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(54) IMPROVEMENTS IN SOLID BOWL SCREW CENTRIFUGES

(71) I, HELMUT BRUCKMAYER, a German citizen trading as FLOTTWEG-WERK DR GEORG BRUCKMAYER GBMH & Co. KG of 8313 Vilsbiburg, Germany, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention concerns improvements in solid-bowl screw centrifuges for separating a solid-liquid mixture and of the kind having an at least partly conical, rotatably driven drum and a screw which is driven to rotate in the drum at a differential speed and whose threads, adapted to the inner wall of the drum, convey to a solids discharge, provided in the conically tapered end region of the drum, the solids deposited under centrifugal force in a separating chamber which is formed between the screw hub and the drum, and having a radially adjustable paring mechanism which engages in a receiving chamber provided outside the separating chamber in the drum end region remote from the solids discharge, and which takes off a first, heavier liquid phase, said centrifuge also having a drain chamber for a second, lighter liquid phase which is bounded with respect to the separating chamber by a weir, is located axially between the separating and receiving chambers, is closed with respect to the receiving chamber and is provided in the drum end cover remote from the solids discharge in the form of compartments spaced around the periphery. Such centrifuges are hereafter referred to as being of the kind described.

A known centrifuge of this kind (DT-OS 21 03 829) works in this way as a so-called three-phased decanting device. By virtue of the radially adjustable paring disc it is possible to influence the boundary zone between the two liquid phases of different density as regards their radial position and, consequently to adapt it to the suspension conditions so that as clean a separation as possible of the two liquid phases is obtained.

The two liquid phases are evacuated from the separating chamber of the centrifuge through the end region of the drum which is remote from the solids discharge. This end region is designed as a cover and has on the known centrifuge an extraordinarily complicated shape. Relatively long channels for the two liquid phases which cross one another are bored through the cover, only the channels for the heavier phase passing axially through the cover and emerging in a receiving chamber in which the paring mechanism engages, while the channels for the light phase are directed radially on the inside of the cover and outwards with bends. Machines with a paring mechanism, especially one which is radially adjustable, belong to high grade decanting apparatus with which difficult separating operations can be carried out. Two-phase machines in which the liquid phase is simply centrifuged off are used more or less only for rough separating work, especially in the field of sludge drainage.

Especially in the field of difficult separating operations there are cases where it is necessary to transfer from two-phase to three-phase operation, in order, for example, to extract certain harmful products in a liquid phase. Such problems arise frequently in the chemical industry, in refining and, above all, in the regeneration of waste oil, if it is intended not only to separate solids such as abrasion dust, etc., but also to separate the remaining waste oil into a lighter phase which can be reused and into a heavier phase. A further example is the extraction of olive oil in which the crushed mass of olives is mixed with water for better processing.

Such change-overs from two-phase to

three-phase operation present considerable difficulties on known machines, especially when they are to be carried out at the place of use. From the point of view of transport and handling of the machine at the place of use, the necessary exchange of drum end covers is extremely laborious and can be carried out on the machine only by several workmen.

A further disadvantage of the above-mentioned known machine consists in that the heavy liquid phase, also, which is removed by a paring mechanism is afterwards centrifuged off radially into a chamber lying next to the extractor chamber for the light liquid phase. Since it is unavoidable for a transition to be made in the region of these extractor chambers from rotating drum parts to stationary housing parts, possibilities of re-mixing of the two liquid phases arise in the region of the transfer points. An attempt has been made to counteract this re-mixing by a labyrinthine design of the transition from the rotating to the stationary housing part, but because of the considerable turbulence in the extractor chambers these labyrinth glands do not provide a reliable seal. Such a possible partial re-mixing between the two liquid phases is especially disadvantageous also because from the point of view of the result of separation it is not possible to establish whether separation is optimum in the centrifuge or whether re-mixing is taking place in the extractor chambers.

It is an object of the invention to provide a centrifuge of the kind described which can be converted with as little difficulty as possible either to two-phase or three-phase operation, in such a way that, if possible, only one workman can make this conversion at the place of operation of the centrifuge.

According to the invention there is provided a centrifuge of the kind described wherein the said compartments are formed as recesses which axially penetrate the drum end cover and a number of which have removable closures in their end region facing the receiving chamber, are covered with respect to the separating chamber, apart from a radially inner region, by an exchangeable weir and have outlet openings closable in a radial direction, while the remaining recesses are covered with respect to the separating chamber, with the exception of a radially outer region, by the said exchangeable weir.

In a centrifuge according to the invention, therefore, a number, preferably half, of a series of compartments which penetrate the drum end cover are formed by closures and weir covers or by the formation of outlet openings radially outwards in such a way that they receive via the weir the lighter liquid phase forming paraxially in the separating chamber and evacuate it outwards through the radial outlet opening, while the closures towards the receiving chamber for the heavier liquid prevent overflow in one direction or the other. The other openings remain open towards the receiving chamber of the paring mechanism and are covered by the weir in such a way that they are connected to the separating chamber in the outer radial region and consequently receive the heavier liquid phase and convey it into the receiving chamber of the paring mechanism.

If it is intended to transfer from this three-phase operation to two-phase operation, the weir variably covering the recesses, as well as the closures of a number of the recesses to the receiving chamber of the paring mechanism are removed and the radial outlet openings are closed. All the recesses then serve in the same way for the overflow of the liquid to be extracted from the separating chamber into the drain chamber to the paring mechanism. Conversely, if the special weir is used, a number of recesses towards the drain chamber are closed and the radial outlet openings of these closed recesses are opened.

The parts required for the change-over between two-phase and three-phase operation are therefore extremely few, relatively light-weight and easy to handle by one workman. For reasons of strength the drum end cover itself is thick enough to make the recesses so spacious that the radial outlet openings can open into them without difficulty. There is therefore no need for an additional cover in the change-over from two-phase to three-phase operation.

The cover and the necessary parts are extremely simple and easy to manufacture in view of their form of construction.

In a preferred construction the recesses are made in the form of bores shaped axially parallel to the drum axis. The radial outlet openings can be designed as threaded gland apertures. The closures for the number of recesses towards the receiving chamber of the paring mechanism can be designed in a simple way likewise in the form of a cover with a flange and can be fixed on the weir disc as an abutment by means of screws passing through the recesses.

In principle the decision as to how many of the recesses present in the drum end cover are to be designed in three-phase operation for receiving the lighter liquid phase and conveying the heavier liquid phase to the paring mechanism can be made according to the quantity of liquid phase occurring at any given time. There is also no problem in deciding to what extent the recesses fulfilling different functions are to be distributed uniformly over the periphery.

In a preferred form of construction which is achieved especially with a small even number of recesses, looking in the peripheral direction of the drum end cover the recesses are alternately opened towards the receiving chamber for conveying the heavy liquid phase into the latter and closed towards the receiving chamber and radially opened for evacuating the lighter liquid phase.

In an especially preferred form of construction the weir is formed from an annular disc which has radially inward and radially outward cut-outs assigned to the recesses and their function.

In an especally preferred form of construction a paring mechanism is used in which the separated liquid is taken off axially. Such a paring mechanism is described in DT-GbmS 142490. By virtue of the axial evacuation of the one liquid phase from the region of the drum it is possible also to obtain separately both liquid phases extracted separately; the possibility of partial re-mixing, however acquired, as is presented, for example, by two parallel extractor chambers, does not arise. Consequently, very clean separation results can be achieved and, in particular, it is possible to establish immediately when the separation is unsatisfactory, that the cause thereof lies in the separating action of the centrifuge or in an incorrect adjustment of the radially adjustable paring mechanism. By varying the radial paring depth the liquid height in the separating chamber and, consequently, the magnitude of the liquid phases removed at any given time can be set to an optimum value immediately.

Evacuation via the paring mechanism into a closed pipe has special advantages also when the heavier liquid phase is to remain, as far as possible, without any contact with air. The substances concerned can be those which are inclined to oxidation, toxic substances and the like. Furthermore, the heavier liquid phase is exempted from the turbulence occurring in an extractor chamber by the fact that one of the two compartment walls rotates. The intensive contact and mixing with air which occurs is very harmful to many liquid phases or the further processing thereof. Finally, there is no need for expensive and laborious sealing measures which have, in any case, not produced satisfactory results hitherto.

A preferred embodiment of the invention will be described with reference to the accompanying drawings in which: —

Figure 1 is a partial cross-section on the line I-I of Figure 2 through the end region of centrifuge in which the paring mechanism is situated and

Figure 2 is a partial plan view, from the direction of the separating chamber, of the weir disc arranged for three-phase operation.

The drum 1 shown in Figure 1 only at its extreme end region surrounds a screw, not shown, between the hub of which and the drum inner wall is formed a separating chamber 2 of the centrifuge. Solid-bowl screw centrifuges or decanters of this kind are known per se and do not therefore require any further explanation.

Figure 1 shows the drum end with the drum end cover 3 which is fixed tightly on the drum 1 in a manner not shown in detail and which is opposite the solids discharge provided at the conically tapered end of the drum. The drum end cover 3 is concentric with the drum and has in its end wall four recesses 4 which are arranged uniformly around the drum axis and each of which has the shape of a bore parallel to the drum axis. Looking from the separating chamber 2, the recesses 4 open into a receving chamber 5 which is bounded by a flanged cover 6 on the side remote from the recesses 4. Engaging in the receiving chamber 5 there is arranged a paring mechanism 7 whose actual paring head 8 is radially adjustable by turning from outside by means of an eccentric not described in detail. The receiving aperture of the paring head opens into an evacuating channel for the liquid received, which runs radially to the region of the axis, then bends in an axial direction, and emerges at 9 outside the cover flange 6 and the liquid can be evacuated through a fixedly connectable pipeline.

In two-phase operation, that is, the liquid and solid suspension is separated only into a solid fraction and a liquid fraction, all the recesses 4 are shaped the same and carry the liquid to be removed from the separating chamber 3 into the receiving chamber 5 and to the paring mechanism 7.

If a change-over to three-phase operation is to be made, that is, if the liquid and solid suspension is to be separated into a solid fraction and two liquid phases of different densities, some of the recesses 4— in the present case half, i.e. two—are converted in such a way that they become a drain chamber for the lighter of the two liquid phases, while the remaining two recesses convey only the heavier liquid phase to the receiving chamber 5 and, thence, to the paring mechanism 7. For this purpose, the recesses for receiving the lighter liquid phase are closed with a cover 10 in their marginal region adjacent the receiving chamber 5, so that no exchange of liquid can take place any longer between these recesses and the receiving chamber 5. Further, all the recesses are covered with re-

spect to the separating chamber 2 by means of a weir 11 in such a way that those recesses 4 intended to receive the lighter liquid phase are connected to the separating chamber in the radially inner part, while those recesses 4 which are to convey the heavier liquid phase out of the separating chamber 2 into the receiving chamber 5 remain connected to the separating chamber at the radially outer region. The weir 11 provided is designed for this purpose in the simplest way in adaptation to the spatial distribution of the recesses, as described with reference to Figure 2.

Those recesses 4 which serve to take off the lighter liquid phase are provided with radially outwardly directed outlet openings 12 which open into a collecting container 13 for the light liquid. The lighter liquid phase is sprayed through the outlet opening 12 into this collecting container.

In event of two-phase operation the outlet openings 12 are closed by means of plugs, not shown, screwed into a thread 14.

By virtue of the special design of the weir 11 the lighter liquid phase passes from the radially inner surface regeion of the pool in the separating chamber 2 into those recesses 4 which are separated from the receiving chamber 5 by means of closures 10. From these recesses the light liquid phase overflows through the outlet openings 12 into the collecting container 13. By virtue of the special design of the weir 11 the heavy liquid phase passes in the radially outer pool region into those recesses 4 which are accessible there and through these into the receiving chamber 5 whence it is picked up by means of the paring mechanism and taken off axially.

In this way, the separated liquid phases can be taken off separately with certainty and are, under no circumstances, subjected to even slight re-mixing.

The view of the weir 11 seen from the separating chamber of the centrifuge reveals its simple design. The weir disc 11 is made symmetrical, which means that, looking in the peripheral direction, the four recesses alternately assume one of the two functions of liquid evacuation in three-phase operation. Figure 1 shows two recesses with different functions in one plane, since Figure 1 is a section on the line I-I in Figure 2.

The weir 11 can be imagined as being made from an annular disc. At two diametrically opposed peripheral points, cut-outs 15 which have the external shape of circular segments are made which leave uncovered two of the four recesses in the outer radial marginal region. Through the exposed areas 16 of these recesses 4 the heavy liquid phase overflows out of the separating chamber 2 into these recesses and on into the receiving chamber 5.

Turned through 90° and, again, in a diametrically opposed arrangement there are provided in the inner marginal region of the annular disc two further cut-outs 17 which now leave uncovered the two remaining recesses in their inner radial marginal areas 18, through which the lighter liquid phase flows out of the separating chamber into the associated recesses 4 and thence through the outlet openings 12 into the collecting container 13.

As can be seen, all the parts concerned are geometrically very simple and, consequently, easily manufactured shapes and they are easy to handle, so that one workman can convert the machine directly from two-phase operation to three-phase operation and vice versa.

Furthermore, the scraping mechanism used ensures clean evacuation of the two liquid phases which prevents especially re-mixing even in the smallest quantities. Consequently, the best separation results can be achieved and unsatisfactory separation results can be rectified by readjusting the paring disc. With regard to the form of construction of such a paring mechanism reference is expressely made to DT-Gbm 1942490.

WHAT I CLAIM IS:—

1. A centrifuge of the kind described wherein the said compartments are formed as recesses which axially penetrate the drum end cover and some of which have removable closures in their end region facing the receiving chamber, are covered with respect to the separating chamber, with the exception of a radially inner area, by an exchangeable weir and have outlet openings closable in a radial direction, while the remaining recesses are covered with respect to the separating chamber, with the exception of a radially outer area, by the said exchangeable weir.

2. A centrifuge according to claim 1, wherein the recesses are in the form of bores formed parallel to the drum axis.

3. A centrifuge according to claim 1 or 2, wherein around the periphery of the drum end cover, the recesses are alternately opened towards the receiving chamber for conveying the heavy liquid phase into the latter and closed towards the receiving chamber and radially open for taking off the lighter liquid phase.

4. A centrifuge according to any one of the preceding claims, wherein the weir consists of an annular disc which has radially outward and radially inward portions cut out which are associated with the recesses and their respective functions.

5. A centrifuge according to any one of the preceding claims, wherein the paring

mechanism has an axially directed liquid take off pipe.

6. A centrifuge of the kind described substantially as described with reference to the accompanying drawings.

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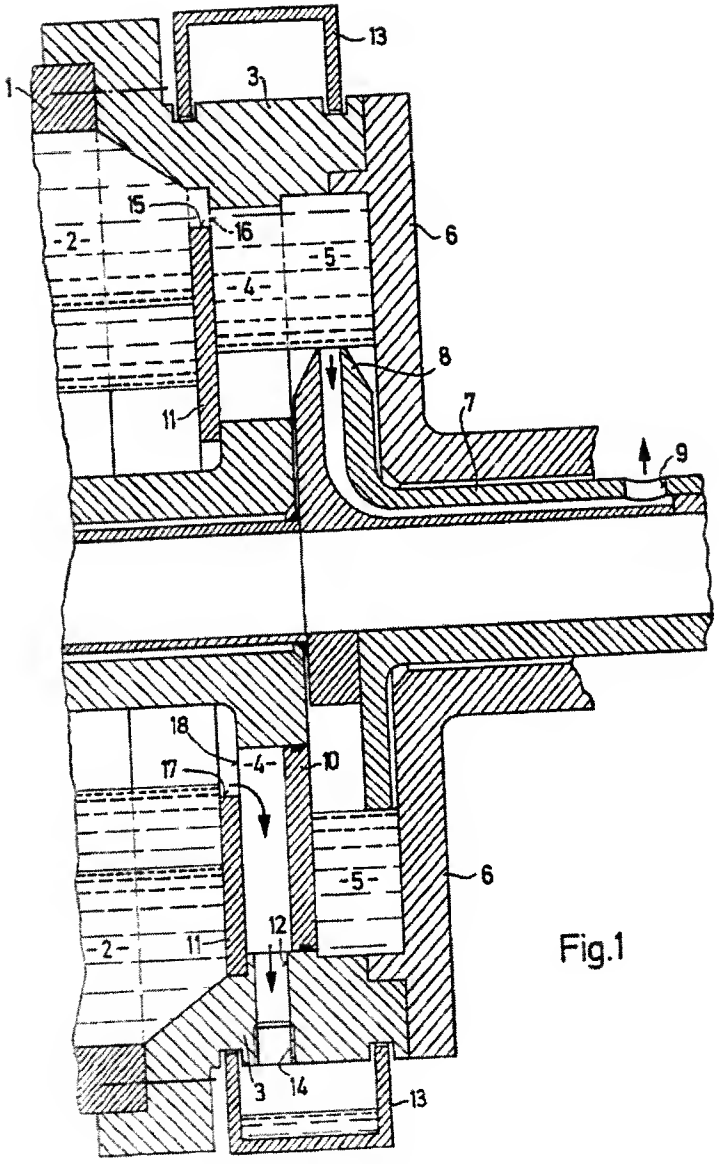

Fig.1

1569520 COMPLETE SPECIFICATION
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Sheet 2

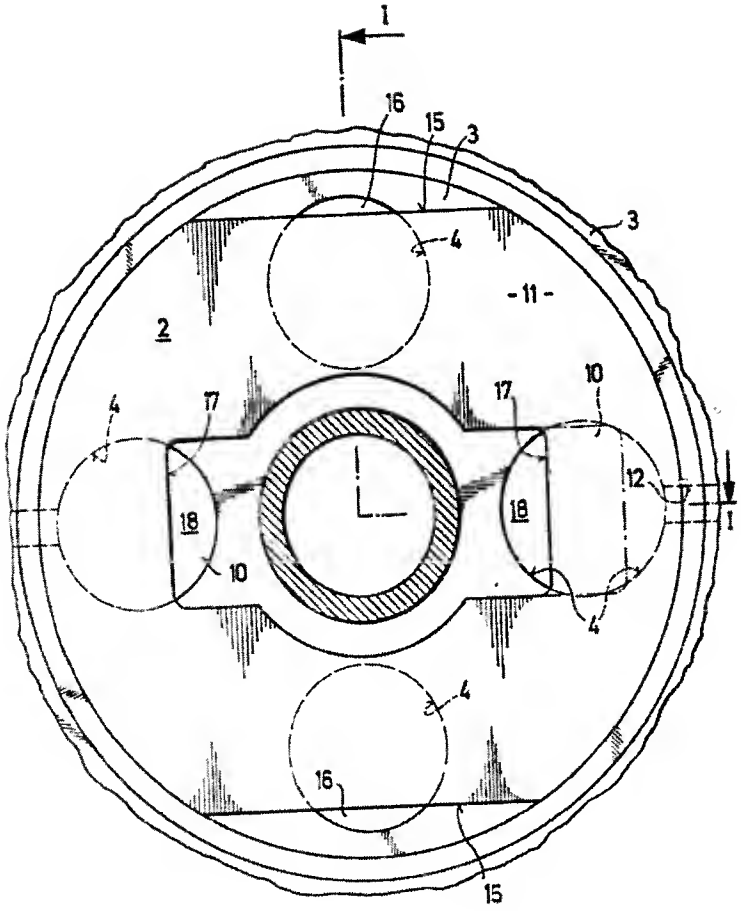

Fig. 2